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A Discriminant Analysis of Grain Market Structure in the South and Cornbelt

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Key Words: Grain Facility Types, Discriminant Analysis, Classification

ABSTRACT

A conceptual paradigm of the U.S. grain marketing system is developed which serves to identify important relationships between economic characteristics and the type of grain facilities being utilized in the South, Eastern and Western Cornbelt regions. Discriminant analysis methodology is used to identify the important discriminating structural variables within and across these regions. It is concluded that livestock and grain deficit related variables are the primary distinguishing characteristics in the South while grain facility services and transportation alternatives comprise the primary structural variables for the Cornbelt.

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Introduction

The grain marketing system in the United States has evolved from a simple process of transporting relatively small grain surpluses directly from farms to the final consumer in its early stages to a highly complex system involving many physical and service oriented functions. Today's grain marketing system is comprised of transportation, processing, merchandising, and service activities carried out by a highly diverse set of production facilities. This diversity exists both within and across major grain producing regions of the U.S. With substantial regional diversity and specialization in grain and livestock production patterns, transportation alternatives, shipping rates, and final market outlets, it is not surprising that the evolutionary process has resulted in unique plant or facility types within specific grain producing regions. What is not as nearly well understood is the relationship between specific economic characteristics of a region and the type of production facility to be found operative in that region.

Past research on this subject has investigated the structural characteristics of various grain producing regions, focusing on the number, type, size, and extent of services offered by those grain handling facilities [Hennen et al., Baldwin and Bateman, and Schnake and Driscoll]. To a large extent, these studies have been primarily descriptive in nature, identifying what exists in the region in question but not attempting to statistically relate the economic characteristics of the region to the type of plant facility found there. Knowledge of

the relationship between key economic variables inherent to a grain producing region and the type of grain handling facility to be found there may well be useful in the design and implementation of future agricultural policies which impact on the region.

This paper reports on a study designed to identify, compare and contrast the grain merchandising industry's structure for selected U.S. grain marketing regions [Lower]. An important sub-objective of that work and the focus of this paper is to identify the significant economic variables which determine the type and mix of grain facilities for three U.S. regions, the South, Eastern Cornbelt and the Western Cornbelt.[1/]

The statistical analysis was carried out by the application of discriminant analysis to primary and secondary data generated for the study. In the following sections of this paper, a grain marketing system paradigm containing four sectors is developed and is applied to the South, the Eastern Cornbelt and the Western Cornbelt. In this paradigm, grain merchandising is defined to include all the physical, exchange and facilitating functions performed by elevators and grain processors. In contrast, the grain marketing system is defined to encompass the grain merchandising sector, the grain input sector and the grain output sector. Following a discussion of the paradigm, the discriminant analysis (DA) technique is reviewed. The third section presents the results and interpretations of the analysis. The conclusions and implications follow in the last section.

Grain Marketing System Paradigm

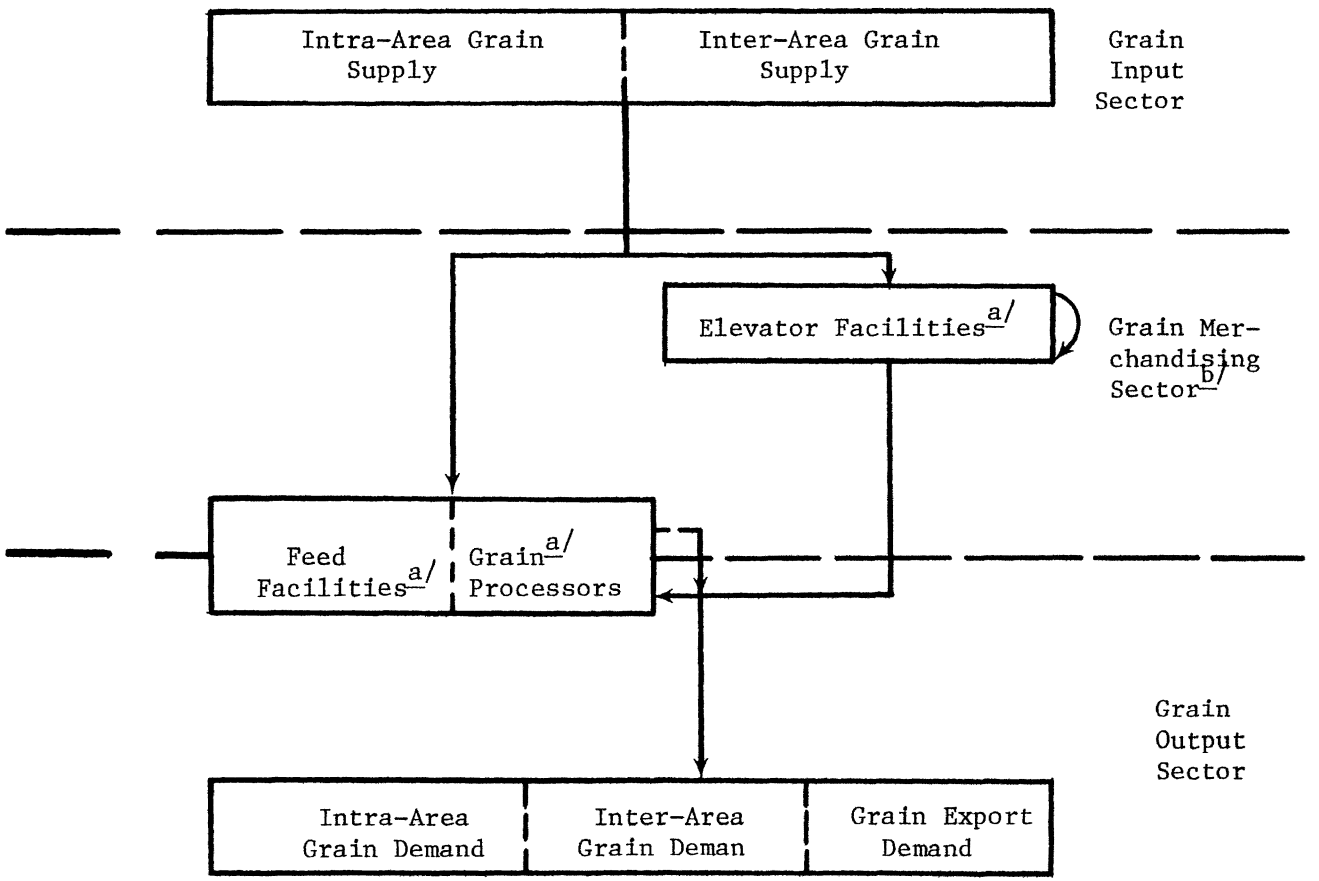
The structure of the grain marketing system can be delineated by

the use of a conceptual paradigm within which the various supply and demand forces for grain and for merchandising services interact (Figure 1). The structure of the grain merchandising sector is examined within the framework of the grain marketing system. The structural characteristics of the input, output and transportation sectors influence and in turn are affected by the structural characteristics of the grain merchandising sector [Lower]. The specific structural variables are presented in Table 1. These variables represent the structural characteristics of the grain marketing system and are thought to be the key variables which serve to differentiate the types of grain facilities within and across regions.

The grain merchandising sector represents the structure of the grain merchandising facilities in the grain marketing system. Included are such structural variables as the types, number and sizes of grain elevators, feed facilities and grain processors. Grain elevators in both the South and Cornbelt perform the exchange and physical marketing functions. Feed plants and grain processors that are located in the South also perform the exchange, spatial and temporal marketing functions. To a lesser extent, processors perform these functions in the Cornbelt [Lower].

The grain input sector represents the structure of the grain supply and service demand side of the grain marketing system. The inter-area supply represents the volume of grain received from regions outside of the area while intra-area farmers provide the intra-area grain supply. Both supplies are used to satisfy the area's demand. Input sector

Figure 1: Grain Marketing System Paradigm



The Transportation Sector is denoted by the solid connecting lines and arrows.

a/ For a definition of grain facility types, see Appendix A.

b/ Merchandising is defined to include all of the physical, exchange and facilitating functions performed at this stage of the grain marketing system.

Table 1: Specified Structural Variables, Definition and Relationship to Grain Market Structure Paradigm in Selected States, 1977

Variable Symbol	Paradigm Sector	Variable Definition
PLNTTYPE	Merchandising	Type of grain facility as determined by definition
STORSIZE	Merchandising	Grain elevator size group as determined by the facility's total permanent grain storage capacity in 1977.
FEEDSIZE	Merchandising	Feed facility size group as determined by the tons of feed produced in 1977.
PROCSIZE	Merchandising	Grain Processor size group as determined by the total bushels of grain processed in 1977.
PERMSTOR	Merchandising	Grain facility's total permanent grain storage capacity in 1977.
FEED	Merchandising	Grain facility's total tons of feed produced in 1977.
PROCGRAN	Merchandising	Grain facility's total bushels of grain processed other than feed in 1977.
STORFARM	Merchandising	Percentage of grain facility's permanent grain storage capacity used to store farmer owned grain on November 30, 1977.

Variable Symbol	Paradigm Sector	Variable Definition
STOROTHER	Merchandising	Percentage of grain facility's permanent grain storage capacity used to store non-farmer owned grain (i.e., CCC, or grain for other firms) on November 30, 1977.
STOROWN	Merchandising	Percentage of grain facility's permanent storage capacity used to store the facility's own grain on November 30, 1977.
STORDP	Merchandising	Percentage of grain facility's grain storage capacity used to store the delayed price grain on November 30, 1977.[a/]
DRYSERV	Merchandising	Availability of grain drying services at the grain facility in 1977. Dummy variable, 1 - yes, 0 - no.
RECTRK	Transportation	Percentage of grain facility's total grain receipts moved by truck in 1977.
RECSING	Transportation	Percentage of grain facility's total grain receipts moved by single-car rail rates in 1977.

Variable Symbol	Paradigm Sector	Variable Definition
RECMUL	Transportation	Percentage of grain facility's total grain receipts moved by multi-car (2-50 cars) rail rates in 1977).
RECUNIT	Transportation	Percentage of grain facility's total grain receipts moved by unit train (65 or 100 cars) rail rates in 1977.
RECWAT	Transportation	Percentage of grain facility's total grain receipts moved by water (barge or ship) in 1977.
SHPTRK	Transportation	Percentage of grain facility's total grain shipments moved by truck in 1977.
SHPSING	Transportation	Percentage of grain facility's total grain shipments moved by single-car rail rates in 1977.
SHPMULT	Transportation	Percentage of grain facility's total grain shipments moved by multi-car (2-50 cars) rail rates in 1977.
SHPUNIT	Transportation	Percentage of grain facility's total grain shipments moved by unit trains (65 or 100 cars) rail rates in 1977.

Variable Symbol	Paradigm Sector	Variable Definition
SHPWAT	Transportation	Percentage of grain facility's total grain shipments moved by water (barge or ship) in 1977.
PERISR	Input	Percentage of grain facility's total grain receipts acquired from interstate origins in 1977.
FARMNO	Input	Number of farms in the crop reporting district in which the grain facility was located in 1977.[b/]
FARMSIZE	Input	The average number of acres per farm in the crop reporting district in which the grain facility was located in 1977.
GRANPROD	Input	Total number of bushels of grain (corn, soybeans, wheat) produced in the crop reporting district in which the grain facility was located in 1977.
GCAU	Output	Number of grain consuming animal units in the crop reporting district in which the grain facility was located in 1977.[c/]
PERISS	Output	Percentage of grain facility's total grain shipments moved to inter-state destinations in 1977.

Variable Symbol	Paradigm Sector	Variable Definition
PERDOM	Output	Percentage of grain facility's total grain shipments moved to domestic, non-export destinations in 1977.
SURDEF	*	Identifies the state in which the grain facility was located in 1977 as a surplus or deficit grain producing area. Dummy variable 1 = surplus, 0 = deficit.

a/ Delayed (deferred) price grain: title of the grain transfers at the time of delivery with the seller having the right to set the price at a later date.

b/ Crop reporting district: a geographical area used by the State Crop and Livestock Reporting Service for the purpose of recording agricultural information.

c/ Grain consuming animal units: a weighted measure of the livestock (cattle, hogs, sheep, and poultry) a crop reporting district produces, based on the average quantity of grain and other concentrates, expressed in feed units, consumed annually by each type in relation to the consumption rate of the average milk cow in the U.S. from 1969 to 1971.

Source: Lower

variables include number and size of farms, grain production, storage services and percent of total grain receipts acquired from interstate sources. These characteristics portray the number and size of grain producers and the volume of grain potentially available to the merchandising industry.

The grain output sector depicts the grain and service demand side of the grain merchandising system. This sector represents the demands of intra-area, interarea, and export buyers for grain and marketing services. Most of the intraarea demand for grain and marketing services originates from the livestock industry (cattle, hogs, sheep and poultry). The importance of the intra-area demand is a function of total livestock production.

The inter-area grain demand represents the demand for grain and marketing services of nonexport facilities outside the area. An important component of this subsector is the grain merchandising sector of grain deficit areas which buys the surplus intra-area grain.

Export demand is the foreign purchase of grain and services. While exports may or may not be possible from a particular intra-area location given the need for port facilities, the influence of export markets is transmitted throughout grain marketing channels. The output sector variables include but are not limited to grain consuming animal units and the proportion of grain moving to interstate buyers and to export points. These variables are expected to be the most important grain output sector variables.

The transportation sector depicts the structural characteristics of the transportation industry as related to the grain marketing system. These characteristics are defined as the type, availability and relative importance of alternative transportation modes (rail, truck and barge) and rates used to ship grain among sectors and areas. Variables in the transportation sector include the percent of total grain receipts and shipments transported by each mode.

Methodology

Discriminant analysis is a broad term which refers to several closely related statistical activities. One of these activities involves interpretation or the study of how groups differ. This is the sense in which we attempt to "discriminate" between groups or types of observations on the basis of some set of characteristics identified from theory or empirical observation. In this discriminating aspect we attempt to evaluate how well the choosen characteristics can delineate observations and which of the characteristics are the most powerful discriminators [Kalecka].

This aspect of discriminant analysis is based on the statistical concept of canonical discriminant functions (CDF). These functions are generally specified as a linear combination of the discriminating variables with the following form:

$$f_{km} = u_o + u_1 X_{km} + u_2 X_{2km} + \ldots\ldots\ldots + u_p X_{pkm}$$

Where

f_{km} = the value on the canonical discriminant function for observation m in the k group;

X_{ikm} = the value for the discriminating variable X_i for observation m in group k;

U_i = the discriminant coefficients for the i^{th} variable.

In general, there will be a number of CDFs corresponding to the number of unique dimensions defined by the discriminant variables. When the addition of new linear combinations of the variables no longer defines a statistically different CDF, then the most recently estimated CDF serves as the termination point in the analysis. Although the actual mathematical and statistical interpretation of discriminant analysis is more complex than this, it is reasonable to state that the last CDF to be estimated is the one which yields the last statistically significant increment in total explained variation of the groups being investigated. The coefficients of this final function, when suitably transformed, can then be interpreted in a relative sense giving an indication of the relative importance of each of the discriminant variables in identifying a particular observation as belonging to a specific group [Klecka, p. 29].

In the results section of this paper, the observations used to derive the CDFs are specific plant types in each of the grain producing regions, while the discriminant variables are the economic characteristics identified by use of the market paradigm. CDFs are derived until the last function estimated does not statistically contribute to the explained variance in plant type. The method of discriminant analysis does not allow sufficiently robust assumptions on the distributions of the estimated parameters so as to be able to test the significance of each estimated coefficient. However, because the method is based on the

concept of multivariate analysis of variance, it is possible to test the statistical significance of each of the estimated CDFs. Even though the individual coefficients cannot be tested, they have an interpretation similar to beta coefficients in regression analysis.[2/] A ranking of the coefficients in absolute value serves to rank each characteristic or discriminating variable relative to its contribution at the margin in delineating plant types.

In addition to the estimation of the discriminating power of the various characteristics, the analysis also includes the development of a related classification function. Even though it may be possible to successfully discriminate among groups of observations (elevators, feed plants and grain processors) within the original sample used to estimate the parameters, it is not certain that the estimated discriminant function will serve to classify a new observation better than random assignment. The classification procedure permits the derivation of a rule in order to assign new observations to a respective group and to use Chi-Square and Tau statistical tests to determine whether or not this assignment is better than random assignment [Klecka].

Data

Under optimal conditions, the entire structure of the grain merchandising sector of the U.S. would be analyzed; however, data limitations restrict the analysis to three regions and a representative state in each region. The selected regions are (1) South - Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virgina and West Virginia; (2)

Western Cornbelt (WCB) - Illinois, Iowa and Missouri; and (3) Eastern Cornbelt (ECB) - Indiana and Ohio. Individual firm data were acquired from the states of Alabama which represents the South, Illinois which represents the Western Cornbelt and Ohio which represents the Eastern Cornbelt. It was hypothesized that Illinois data would be representative of the market structure of the Western Cornbelt, that Ohio data would be representative of the Eastern Cornbelt and that Alabama data would be representative of the South. A chi-square test was used to examine for significant differences in mean levels of grain production, distribution of grain facilities by type and size measured by total permanent storage capacity and it was concluded that these states were statistically representative [Lower].

These data are supplemented with secondary data on grain and livestock production, consumption, processing and transportation taken from the crop and livestock reporting services of Alabama, Illinois and Ohio. All secondary data were acquired on a crop reporting district basis for each of the states.

Statistical Results

The statistical method of discriminant analysis was used to test the marketing system paradigm as a reasonable explanation of observed differences in the types of grain merchandising facilities identified in the alternative regions. First, the discriminant analysis was used to test the statistical ability of the explanatory variables in the merchandising, transportation, input, and output sectors to discriminate among the alternative facilities for each region. The results of the

analysis are presented in Tables 2 and 3. Table 2 contains the parameter estimates for three canonical discriminant function (CDF) for the South and Western Cornbelt regions and four CDFs for the Eastern Cornbelt. These respective sets of CDFs explain at least 98 percent of the total variance in type of plants for the respective regions. The variance and other goodness of fit statistics for the discriminant analysis are presented in Table 3.

A comparison of individual parameter estimates (absolute values) from these functions is more meaningful by observing those variables which do not have significant discriminating power for each region. For example, in the merchandising sector the ability to store farmers grain (STORFARM) is useful in identifying facilities in the Western Cornbelt (.012: Function 1, .202: Function 2, and -.232: Function 3) and Eastern Cornbelt (.039: Function 1, .435: Function 2, .245: Function 3 and .359: Function 4) but is not useful for the South (coefficient approaches zero for all functions). In the input sector, farm size (FARMSIZE) is useful as a discriminating variable in the Western Cornbelt but is not useful for the South or Eastern Cornbelt. In the output sector grain shipments to domestic points (PERDOM) are useful as a discriminating variable in the South, are a relatively insignificant discriminating variable in the Western Cornbelt and are not useful as discriminating variable in the Eastern Cornbelt.

A second use of the discriminant analysis is to standardize the functions in Table 2 into classification rules to test the ability of the functions to correctly classify each observation into the

Table 2: Parameter Estimates for Significant Canonical Discriminant Functions for Classifying Facility Type Models in the South, Western and Eastern Cornbelt Regions, 1977

Variables	SOUTH			WESTERN CORNBELT			EASTERN CORNBELT			
	Function 1	Function 2	Function 3	Function 1	Function 2	Function 3	Function 1	Function 2	Function 3	Function 4
Merchandising Sector										
PERMSTOR	1.205	-0.506	1.953	0.101	-0.081	0.616	-0.526	0.425	0.411	-0.182
FEED	-0.680	0.376	-0.420	-0.041	-0.386	-0.253	0.137	0.191	-0.421	0.468
PROCGRAN	-1.337	0.043	-2.483	-0.120	-0.192	-0.026	0.004	-0.813	-0.186	0.514
STORFARM	a	a	a	0.012	0.202	-0.232	0.039	0.435	0.245	0.359
STOROTHER	a	a	a	-0.233	0.093	-0.111	0.159	0.108	0.596	-0.142
STOROWN	0.215	0.409	0.381	0.006	0.211	-0.212	-0.155	0.233	0.385	-0.170
STORDP	0.669	-0.006	-0.145	a	a	a	-0.095	-0.614	0.156	0.447
DRYSERV	0.253	-0.278	-0.319	a	a	a	-0.136	-0.203	-0.045	0.384
Transportation Sector										
RECSING	a	a	a	-0.339	-0.190	0.022	-0.059	-0.101	0.534	-0.156
RECUNIT	a	a	a	0.019	0.016	0.302				
RECWAT	0.418	-0.625	0.388	a	a	a	a	a	a	a
SHPTRK	a	a	a	0.204	1.633	0.463	-1.064	-0.320	0.948	-0.263
SHPSING	a	a	a	-0.294	0.744	0.235	0.171	0.753	0.158	-0.485
SHPMULT	a	a	a	0.413	1.304	0.413	0.169	-0.227	0.444	-0.530
SHPUNIT	a	a	a	0.313	1.161	-0.149	-0.097	0.337	0.298	0.219
SHPWAT	0.112	-0.502	-0.502	-0.114	0.401	0.149	0.164	-0.188	-0.670	-0.366

Input Sector										
PERISR	-0.185	-0.570	0.029	0.182	-0.193	0.346	0.062	0.408	-1.049	0.627
FARMNO	a	a	a	a	a	a	0.153	0.070	0.351	-0.152
FARMSIZE	a	a	a	0.057	-0.210	-0.186	a	a	a	a
GRAINPROD	a	a	a	0.060	0.161	0.250	a	a	a	a
Output Sector										
GCAU	a	a	a	0.059	-0.185	-0.229	a	a	a	a
PERISS	0.552	-0.071	-0.479	-0.326	-0.283	-0.359	-0.096	0.583	-0.261	0.582
PERDOM	-0.339	-0.346	0.325	-0.012	-0.008	-0.590	a	a	a	a

[a] Denotes variables identified as having little discriminating power in the analysis

Source: Lower

Table 3: Discriminant Function Statistics for the Facility Type Models: South, Western and Eastern Cornbelt Regions, 1977

Function Measurements	S O U T H			W E S T E R N C O R N B E L T			E A S T E R N C O R N B E L T			
	Function 1	Function 2	Function 3	Function 1	Function 2	Function 3	Function 1	Function 2	Function 3	Function 4
Percent of Variance	61.81	20.58	16.51	86.34	10.05	2.22	78.02	10.13	5.69	3.85
Canonical Correlation	0.89	0.75	0.71	0.99	0.92	0.75	0.98	0.86	0.78	0.72
Wilk's Lambda	0.03	0.19	0.45	0.01	0.03	0.21	0.01	0.03	0.11	0.29
Chi-square	195.62	98.83	47.88	1,940.30	904.90	396.67	627.38	332.77	205.99	116.06
Degree of Freedom	44.00	30.00	18.00	95.00	72.00	51.00	90.00	68.00	48.00	30.00
Chi-square Significance	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Source: Lower

appropriate grain facility category for each region. For the South, approximately 99 percent of the variance in facilty types is explained by the first three functions (Table 3). Function 1 explains 61.8 percent of the variance, Function 2 explains 20.6 percent and Function 3 explains 16.5 percent of the variance. Similar results are achieved for the Western Cornbelt. That is, approximately 99 percent of the variance is explained by the first three functions. Function 1 is very powerful explaining more than 86 percent of the variance in facility types. For the Eastern Cornbelt, four functions are required to explain nearly 98 percent of the variance. Nevertheless, the first function for the Eastern Cornbelt explains more of the total variance than does the first function for the South. As demonstrated by the Chi-square test, all classifications are significantly better than random assignment (Table 3).

The classification matrices are presented in Tables 4, 5 and 6. Each table presents the percent of correct and incorrect classifications for each of the facility types in the respective regions. The significant Chi-square statistic presented with each matrix indicates that the classification functions do a better job of facility assignment based on knowledge of the explanatory variables than simple assignment based only on equal prior probabilities.

Regional Comparisons of Facility Type Models

The results of the analyses of the representative regions indicate that the grain merchandising sector variables and the transportation sector variables are the distinguishing characteristics of the Western

Table 4: Alabama Facility Type Model: Classification Matrix and Classification Measurements, 1977

Actual Groups	Total	Predicted Group Membership: Country Elev.	Terminal Elev.	River Elev.	Feed Fac.	Grain Proc.
Country Elev.	25	22	0	2	1	0
	100%	88.0%	0.0%	8.0%	4.0%	0.0%
Terminal Elev.	2	1	1	0	0	0
	100%	50.0%	50.0%	0.0%	0.0%	0.0%
River Elev.	5	1	1	3	0	0
	100%	20.0%	20.0%	60.0%	0.0%	0.0%
Feed Fac.	32	0	0	0	32	0
	100%	0.0%	0.0%	0.0%	100%	0.0%
Grain Proc.	5	0	0	0	2	3
	100%	0.0%	0.0%	0.0%	40.0%	60.0%

Percent of Correct Classification	88.41%
Chi-square	201.80
Chi-square significance	.001
Tau	81.95%

Source: Lower

Table 5: Illinois Facility Type Model: Classification Matrix and Classification Measurements, 1977

Actual Total		Predicted Group Membership					
	Elev.	Country Elev.	Terminal Elev.	River Elev.	Export Fac.	Feed Proc.	Grain Proc.
Country Elev.	127	119	6	0	0	2	0
	100%	93.7%	4.7%	0.0%	0.0%	1.6%	0.0%
Terminal Elev.	29	20	9	0	0	0	0
	100%	69.0%	31.0%	0.0%	0.0%	0.0%	0.0%
River Elev.	65	1	0	64	0	0	0
	100%	1.5%	0.0%	98.5%	0.0%	0.0%	0.0%
Export Elev.	4	0	0	1	3	0	0
	100%	0.0%	0.0%	25.0%	75.0%	0.0%	0.0%
Feed Elev.	18	3	0	0	0	15	0
	100%	16.3%	0.0%	0.0%	0.0%	83.3%	0.0%
Grain Elev.	32	1	0	0	0	6	25
	100%	3.12%	0.0%	0.0%	0.0%	18.8%	78.1%

Percent of Correct Classification	85.45%
Chi-square	936.89
Chi-square significance	.001
Tau	79.27%

Source: Lower

Table 6: Ohio Facility Type Model: Classification Matrix and Classification Measurements, 1977

Actual Groups	Total	Predicted Group Membership: Country Elev.	Terminal Elev.	River Elev.	Export Fac.	Feed Proc.	Grain Proc.
Country Elev.	57	50	1	0	0	6	0
	100%	87.7%	1.8%	0.0%	0.0%	10.5%	0.0%
Terminal Elev.	6	1	5	0	0	0	0
	100%	16.7%	83.3%	0.0%	0.0%	0.0%	0.0%
River Elev.	3	0	0	3	0	0	0
	100%	0.0%	0.0%	100%	0.0%	0.0%	0.0%
Export Elev.	4	0	0	0	4	0	0
	100%	0.0%	0.0%	0.0%	100%	0.0%	0.0%
Feed Fac.	30	6	0	0	0	24	0
	100%	20.0%	0.0%	0.0%	0.0%	80.0%	0.0%
Grain Proc.	7	0	0	0	0	0	0
	100%	0.0%	0.0%	0.0%	0.0%	0.0%	100%

Percent of Correct Classification	86.92%
Chi-square	189.21
Chi-square significance	.001
Tau	79.17%

Source: Lower

and Eastern Cornbelt which are grain surplus producing regions. Livestock related variables, a component of the grain merchandising sector, are the distinguishing characteristics in the South which is a grain deficit region.

The importance of a region's grain surplus or deficit position reflects differing demands placed on the grain merchandising industry. In the facility type model for each region, the surplus or deficit variable was not significant. However, in the model for all three regions combined, this variable was significant and indicates that country, terminal, river and export elevators and grain processors are more likely to be found in surplus areas [Lower]. Country elevators and feed facilities are more likely to be the dominant type of grain facility in deficit areas. This finding is reasonable as secondary grain handling elevators and grain processors are necessary to accommodate and take advantage of surplus grain supply. In deficit grain areas, the intra-area demand for grain is greater than intra-area production which mitigates the requirement for secondary grain handling elevators.

The Southern (grain deficit) region facilities are relatively specialized in grain and feed services, which are required to meet the livestock driven demand for deficit grain. For this reason processing grain, permanent storage, feed produced and interstate grain receipts were identified as key variables for the first function in classifying grain facilities in the South (Table 2). In addition, the delayed price variable was also important. Grain receipts and shipments by water and storage were the most important variables for the second function while

storage, processing, water shipments and feed were the important variables for the third function in classifying grain facilities.

Because the South is a grain deficit livestock feeding region, the classification function differentiates quite well between grain processors and feed facilities and to a lesser extent country elevators (Table 4). The classification function is less able to correctly classify terminal and river elevators, which are limited in number and perform similar temporal and spatial functions.

Grain facilities in surplus areas take advantage of intra-area and inter-area and export marketing opportunities. For the Western Cornbelt, the facility types primarily differentiate themselves by modes of transportation employed to ship grain to deficit regions and export points. Unit train shipments, for example, tend to characterize terminal elevators and to a lesser extent country elevators, while water shipments identify river and export elevators. The input sector's interstate receipts and farm size provide significant classification characteristics. Farm size (intra-region) indicates the relative importance of internal supply factors over external ones. The significance of interstate grain receipts in the Western Cornbelt is indicative of the grain merchandising sector's performance as a middle man for grain from neighboring states.

For the Eastern Cornbelt, the facility type groups are classified predominantly by transportation options used to receive and ship grain and to a lesser extent by merchandising services. For example, water shipments characterize river and export elevators while unit train

shipments identify terminal elevators. Country elevators store farmer-owned grain, whereas export elevators store primarly their own grain.

The Eastern Cornbelt classification functions differeniate between country and terminal elevators while the Western Cornbelt functions do not. This difference reflects unique grain production and marketing characteristics of the respective areas. In the Western Cornbelt, characterized by higher production, a greater surplus and longer distances to major markets, country elevators provide nearly the same functions as terminals; that is, they receive grain from farmers and ship directly to domestic demand centers. In contrast, the Eastern Cornbelt characterized by lower production, a smaller surplus and closer proximity to major markets requires the services of both country and terminal elevators. For example, country elevators in this region move grain in relatively small shipments from farmers directly to Great Lakes export points, to Ohio River facilities, and to processors. Terminals, on the other hand, accumulate grain from farmers and other grain facilities to take advantage of economical transportation options to East Coast and Gulf export points.

Conclusions and Implications

The findings of this study indicate that the structure of the grain merchandising industry varies among the selected grain marketing regions, and that the variations are influenced by regional differences in the input, output and transporation sectors. This study deals only with variations across regions at one point in time (1977), and cannot examine completely the effect of policy decisions. Further collection

of data would enable researchers to study the impact of policy decisions over time.

This study has two major policy implications. First, the development of the grain marketing system paradigm presents a theoretical framework within which to analyze the implications of policy decisions. Second, it demonstrates the use of the discriminant analysis technique to understand the interaction among the paradigm's sectors for three different grain producing regions.

Changes in policies and/or technologies have different effects upon the structure of the grain industry in each region because of regional differences in the structural characteristics of the input, output, transportation and grain merchandising sectors. For example, policies supporting the "small family grain farm," a characteristic of the intraarea input sector have greater impact on the Cornbelt regions (due to the greater demands for grain markets and services created by small grain producers) than in the South. This in turn influences elevator numbers and size in response to farmers' demands. A second intra-area input factor, impacting primarily the Cornbelt regions, is government support for expansion of on-farm storage capacity which reduces the services of existing grain facilities that do not need to provide as much storage for farmers.

In the output sector, policies dealing with the export markets impact the structure of the grain merchandising sector of all three regions. Such policies may alter inter-state grain movements as well as the proportion of total shipments moving to domestic demand centers.

The demand for grain and services cause the merchandising sector to change its marketing strategies and to adjust the services offered and the transportation options used. Transportation policies affect all sectors and regions because of the structural interrelationships among sectors and regions. A change in the transportation facilities in one area impacts the structure in other areas. Finally, policies that affect livestock farmers and feed processors have a greater impact upon the output and grain merchandising sectors in the South than in the Cornbelt.

Footnotes

1. The South is a grain deficit region while the Eastern and Western Cornbelt regions are grain surplus areas [Lazarus, S.S. et al.]. A grain deficit area is defined as one in which the intra-regional disappearance of grain exceeds the intra-regional production of grain and a grain surplus region is defined as one in which the production of grain exceeds the disappearance of grain.
2. The significance of individual parameter estimates by applying the usual "t test" is a questionable procedure for discriminant analysis [Dhyrmes, p. 76].

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Appendix A

Definition of Facility Types Enumerated in 1977 NCSR Grain Survey

1. Country Elevator: A plant that primarily collects and merchandises raw grain. Classification as a country elevator requires that more than 50 percent of the facility's raw grain receipts come directly from farmers, and more than 50 percent of raw grain receipts move out of the facility as raw grain. The definition is not affected by the destination of grain or whether some manufacturing of feed or ingredients takes place at the facility.

2. Terminal Elevator: A plant that primarily collects and merchandises raw grain. Classification as a terminal elevator requires that more than 50 percent of the facility's raw grain receipts come from other grain facilities (as opposed to farmers), and more than 50 percent of raw grain receipts move out of the facility as raw grain. Grain shipments must move to multiple destinations.

3. River Elevator: A plant that primarily collects and merchandises raw grain received from other grain facilities and farmers, and ships grain by river barge to export and domestic demand centers. Classification as a river elevator requires the facility to ship by barge more than 50 percent of total grain receipts.

4. Export Elevator: A plant that primarily collects and merchandises raw grain received from other grain facilities and farmers, and exports grain to foreign countries. Classification as an export elevator requires the facility to export more than 50 percent of total grain receipts.

5. Feed Manufacturer: A plant whose primary activity includes manufacturing a brand name of feed. To be classified as a feed manufacturing plant, more than 50 percent of its revenue must come from the sale of feed products.

6. Feed Mill: A plant whose primary activity is grinding grain into feed for farmers and whose major economic activity is not the manufacturing of a brand name of feed. More than 50 percent of its revenue must come from grinding and the sale of mixed feeds.

7. Flour Mill: A plant whose primary activity is the milling of wheat flour(s) that result from complete milling of at least 50% of the wheat flour(s) received. The firm may also do blending of imported flour(s) but these cannot exceed the volume milled by the firm. This plant must earn at least 50% of its revenue from the sale of products produced from wheat.

8. Corn Mill: A firm whose primary activity is the processing of shelled corn into a group of diversified products such as starch, dextrin, corn syrup, corn oil, corn meal, corn flour or grits. A firm may process either yellow corn, white corn, or both. Classification as a corn mill requires the processing of more than 50 percent of corn receipts.

9. Soybean Processor: A plant whose primary activity is extracting oil and processing meal from soybeans as joint products of the operation. To be classified as a soybean processor, the plant must receive more than 50 percent of its revenue from processed products of soybeans.

10. Integrated Livestock Firm: A firm, which could otherwise be classified as a feed manufacturer or feed mill, but whose operation involves the raising of broilers, eggs, other poultry, or other livestock as part of a total operation, and more than 50 percent of its revenue comes from the sale of poultry or livestock products. In order to be classified under this category, such a firm must receive at least some raw grain as part of the total operation.

11. Others: Those firms not fitting any of the above classifications but receiving raw grains as part of their operation. These plants tend to be small firms which are located relatively close to urban centers.